Attachment J.1

Gun Weapon System MK34 Mod4

Prototype Display Subsystem

Requirements

1 INTRODUCTION

The MK34 Mod4 Gun Weapon System (GWS) is being developed to replace the MK86 Gun Fire Control System as a part of the CG-47 Class Cruiser Conversion Upgrade Program. T25 is developing a Gun Weapon System (GWS) console. Work to date has produced an early prototype developed around Primagraphics radar and video processing cards. These cards are unique in that they accept the following; specialized radar video input formats, 12 camera video inputs which support the required video formats, support for maps, support for numerous X-Windows graphics overlays, and support for real-time digital display recording. Prototype software developed to date utilizes low level Primagraphics library calls.

The next step toward meeting the MK34 GWS display requirements is procurement of a display subsystem to support integration with other prototype console hardware and software. This display subsystem shall consist of a set of cards, associated hardware, and an associated software toolset. T25 engineers are familiar with the Primagraphics toolset and software application program interfaces (API). This display subsystem cardset must be compatible with the existing prototype hardware and software interfaces, while providing capability to handle real-world input requirements.

2 DISPLAY SUBSYSTEM REQUIREMENTS

The GWS Console prototype display subsystem (DS) shall provide displays to two display screens. Operator controls coming into the display subsystem consist of a keyboard, and a trackball assembly.

The DS shall support radar video display at either display surface. Radar displays shall consist of X-Window displays, a Plan Position Indicator (PPI), and up to two B-Scan displays simultaneously, up to three radar windows total on the radar display.

The DS shall have the capability to display video from multiple video sources at either display surface. Video displays shall consist of X-Window displays, and 1, 2, 3, or 4 video display windows simultaneously.

The radar displays and video displays shall be on different monitors and can be switched.

A screen capture capability shall be supported to ‘snapshot display pixels’ and store them to disk.

2.1 Overview

The prototype display subsystem shall consist of two Host processor cards, a CAT Panther-A card, two Talon cards, a Cobra card, and a Cross Point Switch (refer to Figure 1).

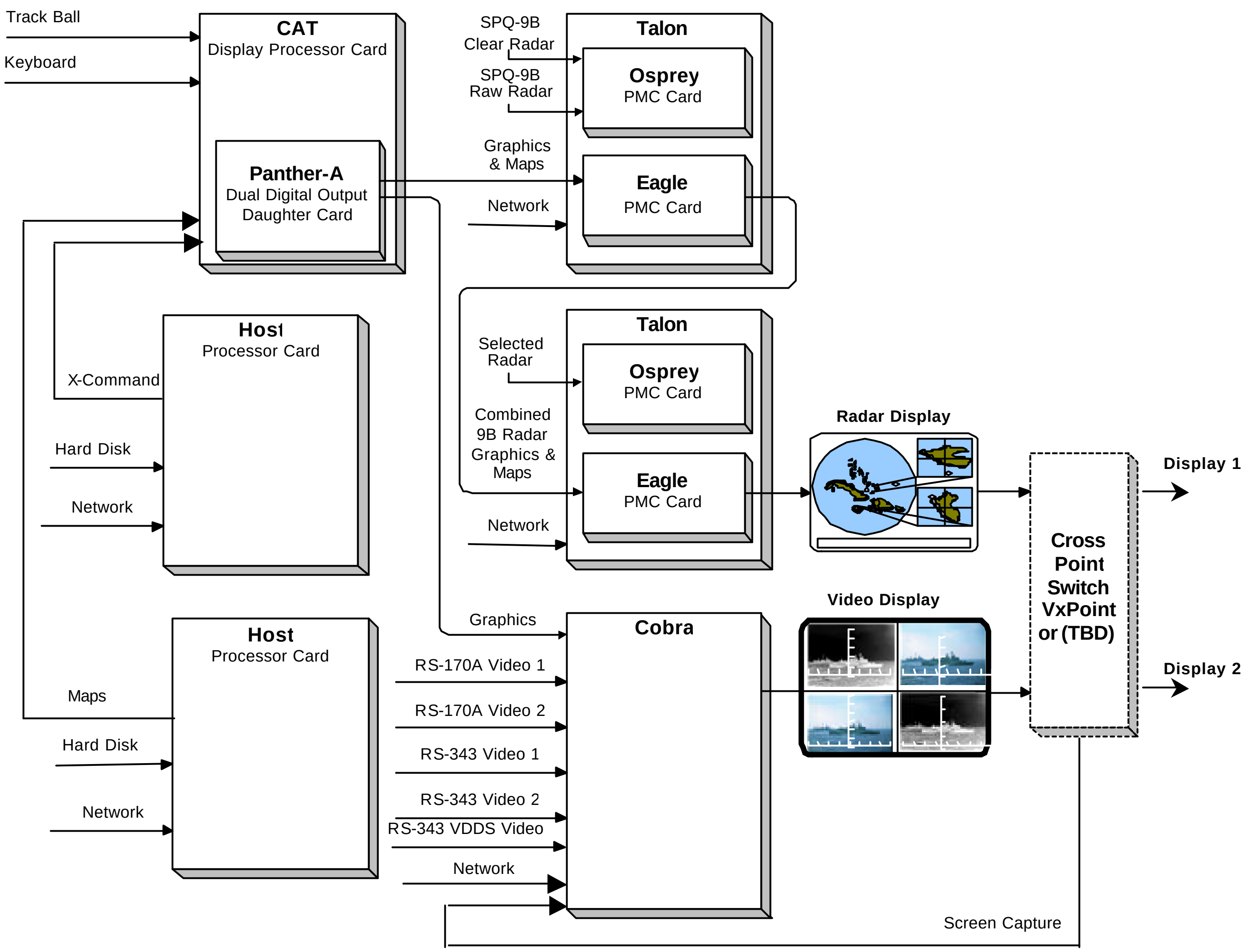

Figure 1 – Block Diagram

The display subsystem requirements are described in the following five sections – interfaces, radar processing, video processing, miscellaneous processing, and additional system components.

2.2 External Interfaces

The DS shall accommodate the following external interfaces.

2.2.1 Local Area Network (LAN)

The DS shall provide switched connection capability to IEEE 802.3, IEEE 802.3u, and IEEE 802.3z Ethernet networks, using the Open System Interconnect (OSI) protocol, the Transmission Control Protocol/Internet Protocol (TCP/IP), and/or User Datagram Protocol (UDP).

2.2.2 Electro-Optical Sensor System (EOSS) (2)

The DS shall receive video from two Electro-Optical Sensor Systems (EOSS). Each EOSS shall provide the DS with simultaneous reception of Daylight Imaging System (DIS) video in RS-343 color R,G,B format with Sync On Green, and Thermal Imaging System (TIS) video in RS-170A composite format.

2.2.3 Video Data Distribution System (VDDS)

The DS shall receive video from VDDS. The VDDS shall provide the DS with video as RS-343 color R,G,B format with Sync On Green.

2.2.4 Radar (3)

The DS shall accept radar sensor input from three radar sources:

1. AN/SPQ-9B Clear – Defined as processed video data that is effectively digital.
2. AN/SPQ-9B Raw – Defined as non-processed, standard radar video.
3. Selected Radar – Defined as radar output from the SB-4229C radar switchboard. This output will normally be from any of the following radars; AN/SPY-1, AN/SPQ-9B, LAMPS and AN/SPS-73 Radars

Details for the radar signal characteristics are given in Appendix A.

2.3 Radar Processing

Radar displays shall consist of X-Window displays, a Plan Position Indicator (PPI) and up to two B-Scan displays simultaneously. X-Window displays are X11R6 protocol. CAT shall accept X-windows from both of the two Host processors. The PPI and B-Scan shall support map and graphics underlays, radar overlays supporting radar video fading, and X-Window graphics, symbols, and text overlays. Map data shall be provided by Intermaphics's Gallium software running on one of the Host processors. The radar video data shall be updated at the native radar video sweep rate. The PPI center and map and graphic underlays shall be updated at a rate up to 1Hz to account for own ship's movement. The B-Scan position and maps and graphic underlays shall be updated at a rate up to 4Hz to account for own ship and target movement. The X-Window graphics, symbols, and text windows and radar overlays shall be updated at a rate up to 32Hz.

There are three radar inputs to the radar processing chain – The SPQ-9B clear, the SPQ-9 raw and the Selected radar. The SPQ-9 radar video input maximum range is 40,000 yards. The Selected radar video input maximum range is 256 data miles. (A data mile is defined as 2,000 yards.) The SPQ-9 raw and clear video bearing is formatted as ACP and ARP, where the ARP is relative bow crossing. The SPQ-9 clear and raw shall be transformed to a stable true north reference. Stabilization shall in the form of offsets to newly arriving radar video. Transformation to a stabilized mode shall occur at as high a frequency as possible. Own ships heading shall be provided via the network interface at 100Hz to accomplish this. The Selected radar video bearing is provided referenced to True North and is formatted as Delta X/Cos Delta X and Delta Y/Sin Delta Y.

The B-Scan is a periodically repositioned zoom window displaying a region 2,000 meters in range and 11.25 degrees (256 SPQ-9 ACPs) in bearing. Ownship is always at the bottom of the B-Scan display. The B-Scan is repositioned to keep the target centered in the B-Scan.

All three radar video images will be displayed together in both the PPI and B-Scan windows. Because of this, all radar video images shall be scaled in range and offset to match the operator selected view. Since the SPQ-9B clear and raw data are from the same source, they are implicitly scaled in range and offset.

Figure 2 depicts a notional representation of the radar video display based on the required processing.

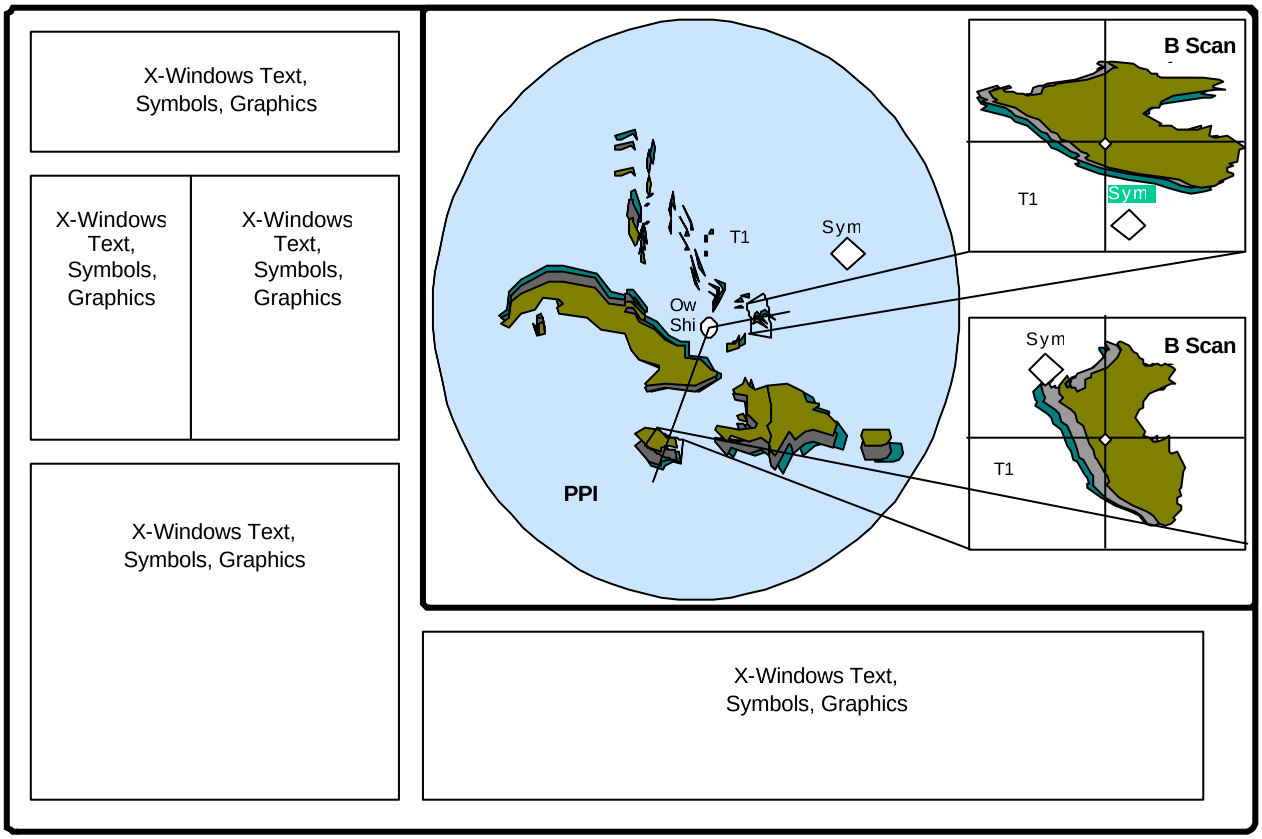

Figure 2 -Radar Display

The display subsystem shall contain two independent scan converters, each of which will comprise an Osprey and an Eagle card (see Figure 1 above). One of the outputs from the CAT/Panther-A graphics card will be fed into the first Eagle where it will be combined with radar SPQ-9B radar videos. The output from first Eagle will feed into the second Eagle where the Selected radar will be added.

The radar color look-up table on the first Eagle will be set so that the radar colors are underlay colors. This will allow the SPQ-9B radar videos to be mixed with the selected radar in the second Eagle. For pixels where the Selected radar is brighter than the SPQ-9B video, the SPQ-9B radar video will be obscured. In all other cases the Selected radar will be obscured.

The first Osprey card will digitize the two SPQ-9B synchronized radar inputs (the clear and raw video). The Clear video is a bi-level signal that is either on or off, and the actual 'on' voltage for the Clear video will be controllable. The Raw video is normal analogue video. The operator will be able to vary the gain of both signals so that. The clear and raw signals will be sampled together and the Osprey will decide which of the two signals should be passed to the Eagle for each sample.

This will be achieved by generating 7 bits of raw video and adding in the 1 bit of clear video before feeding the combination into a look-up table. The signal which has the higher effective amplitude will be output, i.e. either (clear x clear_gain) or (raw x raw_gain). The least significant bit of the result will indicate whether the sample value represents the raw or the clear radar value.

The following controls shall be provided for each radar input;

- Voltage Level Gain and Offset - Each radar input shall have independent voltage level adjustment for both gain and offset. This shall be adjustable through operator control or by programmed presets.
- Range Offset and Azimuth Offset – Each radar input shall have independent range offset (trigger delay) and azimuth offset (azimuth reference pulse offset). Since the SPQ-9B clear and raw signals are synchronous, adjustment to one will automatically set the other. This shall be adjustable through operator control or by programmed presets.
- Color Assignment - Each radar video signal shall have independent color assignment. Color assignments shall be set through operator control or by programmed presets.
- Gain (Brightness) - Each radar video signal shall have independent gain adjustment. Gain settings shall be adjustable through operator control or by programmed presets. A gain of zero shall be used to “turn off” the display of any of the inputs.
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The following special controls shall be provided for the PPI display;

- Range Scale - The PPI range scale is variable from ½ data mile to 256 data miles.

The following special controls shall be provided for each B-Scan display;

- Bearing Center and Range Center - Each B-Scan display is repositioned to keep the target centered in the B-Scan.

2.4 Video Processing

There are five identified video input sources on 11 input lines. The VDDS selected video shall be in RS-343 format. There is a RS-170A and RS-343 input from one EOSS, and a RS-170A and RS-343 input from the second EOSS. Figure 3 depicts a notional representation of the video display screen based on the required processing.

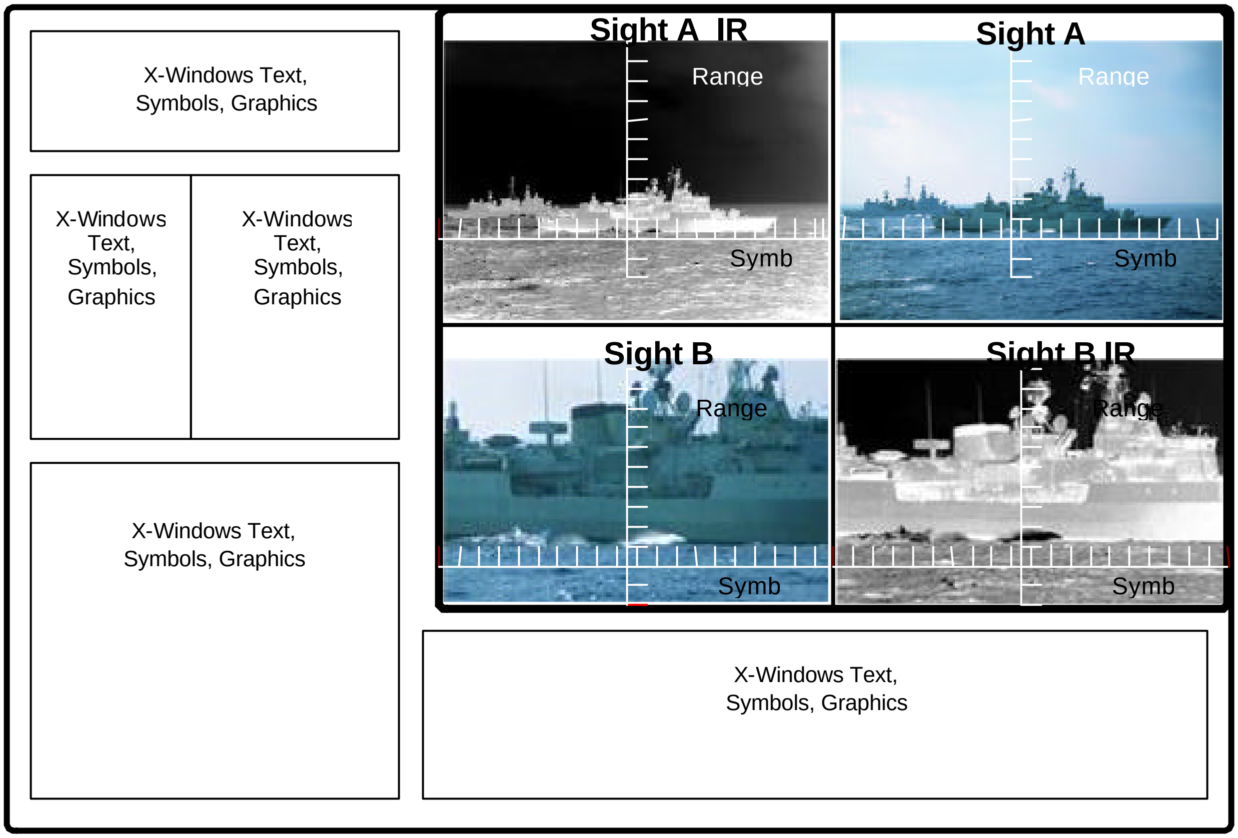

Figure 3 –Video Display.

- Up to four windows shall be displayed concurrently. It shall be possible for the operator to select one, two, three, or four windows for display at any time.
- Display of which video is in which window shall be set through operator control or by programmed presets.
- The windows shall be fixed sizes, either full size or ¼ size. The widow size shall be set through operator control or by programmed presets.
- Each window shall be capable of independent scaling and zooming and shall be set through operator control or by programmed presets.
- Each window shall be capable of displaying overlay graphics.
- Each window shall be capable of independent contrast and brightness that shall be set through operator control or by programmed presets.

2.5 Miscellaneous Processing

- Video data output to the display monitors shall be capable of being switched from one monitor to another using (a) keyboard commands, and (b) using a message from Host processors to the CAT processor.

- Output to both monitors shall be displayed at either 1280X1024 or 1600X1200 resolution. The prototypes shall be configured to use analog CRT monitors.
- The display subsystem shall be capable of accepting input commands from another application via (a) messages from Host processors to the CAT processor, and (b) via the network interfaces the Talon and Cobra Cards.
- The trackball/buttons shall be connected to the CAT processor to provide the functionality of a mouse in the X- Windows environment, and shall be configured to also provide a "position" signal output to the other processors across the backplane.
- Each card of the display subsystem shall support BIST and SOAK Diagnostics with initialization and status available from the console, via backplane memory. Additionally BIST shall be performed by each card at power on.
- Host processor application software which demonstrates each of the required SFA and diagnostic features.
- The display subsystem shall provide a console window interface (VT-100 terminal) to the Host processor.

2.6 Additional System Components

In addition to the electrical components mentioned above, the display subsystem system shall include the following components;

SAF source code, executables, and software users manuals
PARIS Library and software users manuals
BIT software source code, executables, and manuals
Diagnostic test software source code, executables, and manuals
FAT test plan
Display subsystem technical manuals

2.6.1 Software Architecture Framework

In addition to the electrical components mentioned above, the system shall include a System Application Framework (SAF). The SAF will control the Primagraphics hardware and provide the graphic subsystem with the radar interface, video interface, and display functionality.

1. Demonstrate the operation of all supplied hardware with Factory Acceptance Test (FAT).
2. Demonstrate that the SAF/Hardware will meet the functional requirements as contained in this document.

APPENDIX A

AN/SPQ-9B CLEAR AND RAW

The Clear and Raw radar inputs are from the same source. As such, the ACP and ARP signals are the same. The radar data is not north stabilized and is always relative. The radar signals shall have the following characteristics:

Azimuth Change Pulses

Voltage = 0 to 10v ±3vdc at the end of 250 ft of 75Ω coax cable.
Pulse width = 10 ±3.0 µs
Pulse rep. Rate = 8192 equally spaced pulses per antenna revolution
Rise time (10 to 90%) = 0.3 µs max.
Fall time (10 to 90%) = 0.5 µs max.
Load impedance = 75Ω

Azimuth Reference Pulses

Voltage	= 0 to 10v ±3vdc at the end of 250 Ft of 75Ω Coax Cable.
Pulse Width	= 10 ±3.0 µS
Pulse Rep. Rate	= 1 Pulse Per Antenna Revolution
Rise Time (10 To 90%)	= 0.3 µS Max.
Fall Time (10 To 90%)	= 0.5 µS Max.
Load Impedance	= 75Ω

Primary-video Trigger

Voltage	= 0 to 10v ±3vdc at the end of 250 ft of 75Ω coax cable.
Pulse width 50%	= 1.5 ±0.5 µs
Load impedance	= 75Ω

Clear Plot Video

Voltage	= 0 to +2.0 v at the end of 250 ft of 75Ω coax cable.
Bandwidth	= dc to 4.0 MHz
Load impedance	= 75Ω

Raw Video

Voltage	= 0 to +2.0 v at the end of 250 ft of 75Ω coax cable.
Bandwidth	= dc to 4.0 MHz
Load impedance	= 75Ω

PRF Rates

Pulse Per Second	= 3858, 3831, 3805, 3753, 3138, 3491, 3415, 3324, 2765, 2682, 2604, and 2551

Antenna Scan Rate

Revs Per Second	= 2.16

SELECTED RADAR

The Selected radar is output from the SB-4229C radar switchboard. All selected radar sweep positioning and timing signals have been converted to UYQ-21 format by an AN/UYQ-21(V) Radar Azimuth Converter (RAC). For sweep positioning these signals consist of Delta X/Cos Delta X and Delta Y/Sin Delta Y. For sweep timing, the signals are End of Sweep (EOS)/Range Marks. All video and sweep data has been converted to a stabilized reference. This output will normally be from any of the following radars; AN/SPY-1, AN/SPQ-9B, LAMPS, and AN/SPS-73 Radars. The UYQ-21 signal characteristics are as follows:

<u>Delta X/Sign Delta X and Delta Y/Sign Delta Y</u>

Amplitude:	Zero State = 0 +/-0.5 Vdc, maximum state = +5 +/- 1 Vdc. Short duty cycle indicates negative sign and long duty cycle indicates positive sign.
Pulse width:	40 +/- 8 nanoseconds at 50 percent amplitude
Rise and Fall Times:	Rise time equal to or less than 15 nanoseconds (1 volt to 4 volts). Fall time equal to or less than 15 nanoseconds (4 volts to 1 volt).
PRF:	Vary from 0 to 10.5 million pulses per second
Load:	Tri-axial cable terminated in a resistance of 75 ohms +/- 5 percent. The outer shield grounded to chassis. Signal received differentially.

<u>Range Marks/EOS inputs</u>

Reference:	Settable to 2.5 Vdc
Amplitude:	EOS, 0 +/-0.5 Vdc, Range Marks, +5 +/-0.5 Vdc
Pulse Width:	For Range Marks, 180 +/- 100 nanoseconds at 50 percent amplitude. For EOS, 350 +/- 150 nanoseconds at 50 percent amplitude.
Rise and Fall Times:	Rise time equal to or less than 15 nanoseconds. Fall time equal to or less than 15 nanoseconds (measurements between 10 and 90 percent above and below the reference level, as appropriate).
PRF:	Range Marks may vary from 0 to 82 thousand pulses per second (KPPS). EOS may vary from 0 to 1 MPPS.
Load:	Tri-axial cable terminated in a resistance of 75 ohms +/- 5 percent. Outer shield grounded to chassis. Signal received differentially.

Radar video from all Selected radars have been normalized. The video signal characteristics are as follows:

<u>Radar Video</u>

Voltage	= 0 to +2.0 v at the end of 250 ft of 75Ω coax cable.
Bandwidth	= ?
Load impedance	= 75Ω, +/- 5 percent